3A, 4MHz High Efficiency Synchronous Buck Converter AP3409

General Description

The AP3409 is a current mode, PWM synchronous buck DC/DC converter, capable of driving a 3A load with high efficiency, excellent line and load regulation. It operates in continuous PWM mode.

The AP3409 integrates synchronous P-channel and N-channel power MOSFET switches with low on-resistance. It is ideal for portable applications powered from a single Li-ion battery. 100% duty cycle and low on-resistance P-channel internal power MOSFET can maximize the battery life.

The switching frequency of AP3409 can be programmable from 300kHz to 4MHz, which allows small-sized components, such as capacitors and inductors. A standard series of inductors from several different manufacturers are available. This feature greatly simplifies the design of switch-mode power supplies.

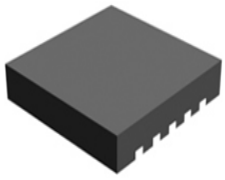
The AP3409 is available in DFN-3×3-10 package.

Features

- Input Voltage Range: 2.6 to 5.5V
- Adjustable Output from 0.8 to 5V
- 0.8V Reference Voltage with ± 2% Precision
- Output Current: 3A
- High Efficiency up to 95%
- Low R_{DSON} Internal Switches
- Programmable Frequency: 300kHz to 4MHz
- Current Mode Control
- Forced Continuous-mode Operation
- 100% Duty Cycle
- Built-in Soft-start
- Built-in Short Circuit Protection
- Built-in Thermal Shutdown Protection
- Built-in Current Limit Function
- DFN-3×3-10 package

Applications

- Portable Media Player
- Digital Still and Video Cameras
- Notebook



DFN-3×3-10

Figure 1. Package Type of AP3409

Pin Configuration

DN Package

(DFN-3×3-10)

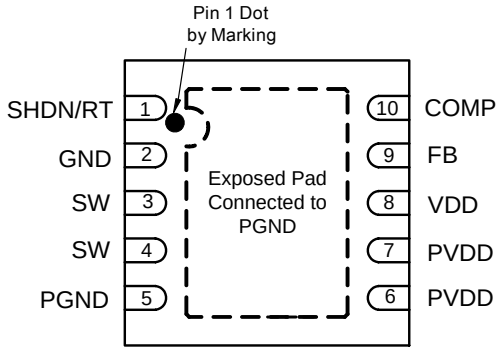


Figure 2. Pin Configuration of AP3409 (Top View)

Pin Description

Pin Number	Pin Name	Description
1	SHDN/RT	Oscillator resistor input. Connect a resistor to GND from this pin to set the switching frequency. Forcing this pin to V_{DD} to shutdown the device
2	GND	Signal ground. All small-signal ground, such as the compensation components and the exposed pad should be connected to this pin, which in turn connects to PGND at one point
3, 4	SW	Internal power switch output. Connect this pin with one terminal of the inductor
5	PGND	Power ground. Connect this pin as close as possible to C_{IN} and C_{OUT}
6, 7	PVDD	Power Input Supply. Decouple this pin to PGND with a capacitor
8	VDD	Signal input supply. Decouple this pin to GND with a capacitor. Normally V_{DD} is equal to V_{PVDD}
9	FB	Feedback voltage. This pin is the inverting input of internal error amplifier. It senses the converter output voltage through an external resistor divider. The internal reference voltage is 0.8V, which determines the output voltage through the resistor divider
10	COMP	Compensation input. This pin is the output of internal error amplifier. Connect external compensation elements to this pin to stabilize the control loop

Functional Block Diagram

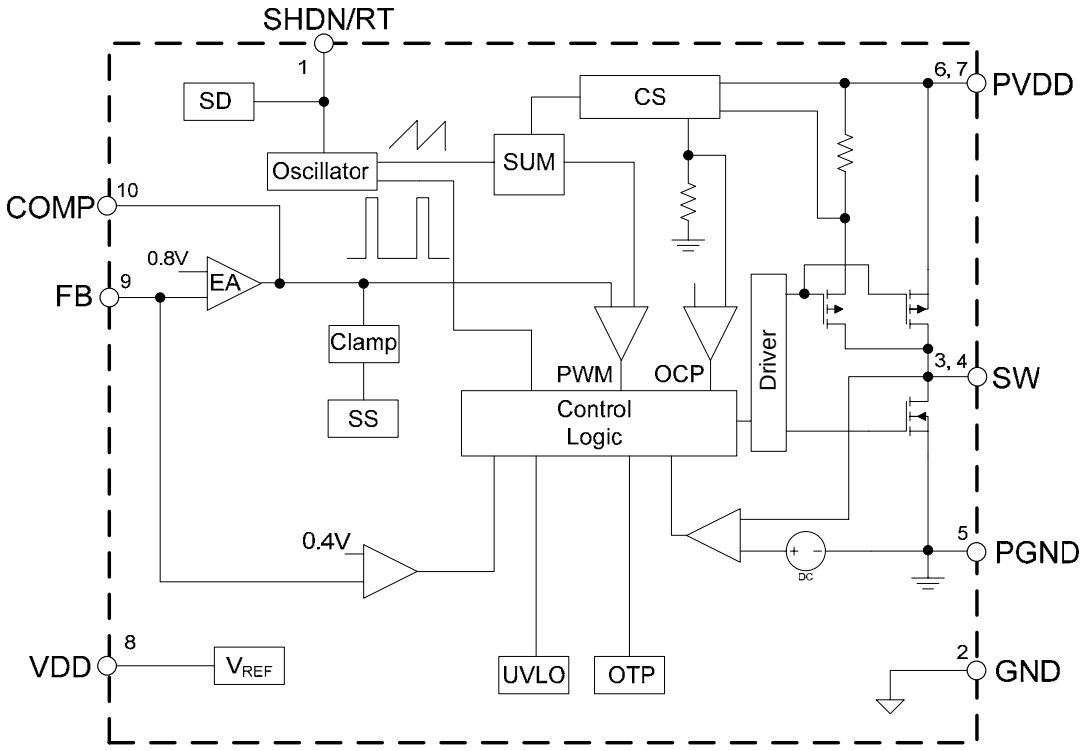
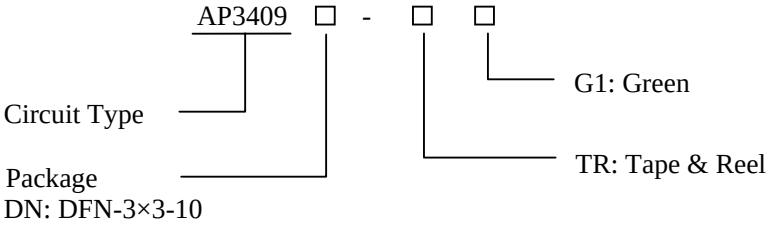


Figure 3. Functional Block Diagram of AP3409

Ordering Information



Package	Temperature Range	Part Number	Marking ID	Packing Type
		Green	Green	
DFN-3×3-10	-40 to 85°C	AP3409DNTR-G1	BDA	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "G1" suffix in the part number, are RoHS compliant and green.

Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Value	Unit
VDD Pin Voltage	V_{DD}	-0.3 to 6	V
PVDD Pin Voltage	V_{PVDD}	-0.3 to 6	V
FB Pin Voltage	V_{FB}	-0.3 to 6	V
COMP Pin Voltage	V_{COMP}	-0.3 to 6	V
SW Pin Voltage	V_{SW}	-0.3 to V_{IN}+0.3	V
SHDN/RT Pin Voltage	V_{RT}	-0.3 to 6	V
Thermal Resistance	θ_{JA}	110	°C/W
Operating Junction Temperature	T_J	150	°C
Storage Temperature	T_{STG}	-65 to 150	°C
Lead Temperature (Soldering, 10 sec)	T_{LEAD}	260	°C
ESD (Machine Model)		200	V
ESD (Human Body Model)		2000	V

Note 1: Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “Recommended Operating Conditions” is not implied. Exposure to “Absolute Maximum Ratings” for extended periods may affect device reliability.

Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit
Input Voltage	V_{IN}	2.6	5.5	V
Maximum Output Current	$I_{OUT\ (MAX)}$	3		A
Operating Junction Temperature	T_J	-40	125	ºC

Electrical Characteristics

V_{IN}=V_{DD} =V_{PVDD}=3.3V, T_A=25℃, unless otherwise specified.

Parameters	Symbol	Conditions	Min	Typ	Max	Unit
INPUT SECTION						
Input Voltage Range	V_{DD}		2.6		5.5	V
Supply Current	I_Q	V_{FB}=0.75V, No Switching		460		μA
Shutdown Supply Current	I_{SHDN}	Shutdown, V_{IN}=5.5V			1	μA
Under Voltage Threshold Lockout	V_{UVLO}	V_{DD} Rising		2.2		V
Under Voltage Hysteresis Lockout	V_{HUVLO}			300		mV
FEEDBACK SECTION						
Feedback Voltage	V_{FB}		0.784	0.8	0.816	V
FB Pin Bias Current	I_{FB}			0.1	0.4	μA
Current Sense Transresistance	R_T			0.2		Ω
Switching Leakage Current		$V_{SHDN/RT}$=V_{IN}=5.5V			1	μA
Error Gain Amplifier Voltage	G_V			800		
Error Amplifier Trans-conductance	G_S			800		μA /V

Electrical Characteristics (Continued)

V_{IN}=V_{DD} =V_{PVDD}=3.3V, T_A=25℃, unless otherwise specified.

Parameters	Symbol	Conditions	Min	Typ	Max	Unit
OSCILLATOR SECTION						
RT Pin Voltage	V_{RT}		0.76	0.8	0.84	V
Switching Frequency	f_{OSC}	R_{OSC}=330kΩ	0.8	1	1.2	MHz
		ADJ Frequency	0.3		4	MHz
Maximum Duty Cycle	D_{MAX}	V_{FB}=0.75V	100			%
POWER SWITCH SECTION						
Switch Current Limit	I_{LIMIT}	V_{FB}=0.75V	3.2	4.2		A
Internal P-FET On Resistance	R_{PDSON}	I_{SW}=500mA		0.11	0.16	Ω
Internal N-FET On Resistance	R_{NDSON}	I_{SW}=-500mA		0.11	0.17	Ω
SHDN/RT SECTION						
Shutdown Threshold				V_{DD}-0.7	V_{DD}-0.4	V
TOTAL DEVICE						
Output Current	I_{OUT}	V_{DD}=2.6 to 5.5V V_{OUT}=2.5V	3			A
Output Voltage Line Regulation	LNR	V_{DD}=2.7 to 5.5V I_{OUT}=100mA		0.4		%/V
Output Voltage Load Regulation	LOD	I_{OUT}=0.01 to 3A		±0.2		%
Soft-start Time	T_{SS}	I_{OUT}＝10mA		1.5		ms
Thermal Shutdown Temperature	T_{OTSD}			160		ºC
Thermal Shutdown Temperature Hysteresis	T_{HYS}			20		ºC

Typical Performance Characteristics

V_{IN}=V_{DD} =V_{PVDD}=3.3V, T_A=25℃, unless otherwise specified.

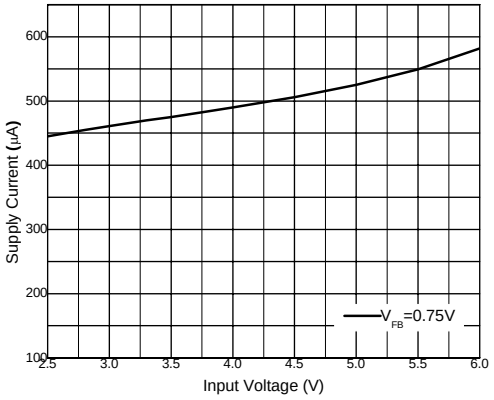


Figure 4. Supply Current vs. Input Voltage

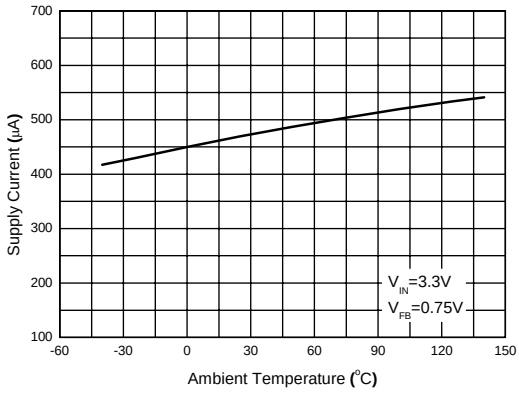


Figure 5. Supply Current vs. Ambient Temperature

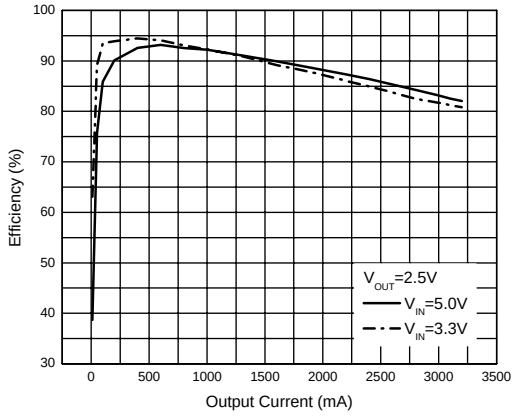


Figure 6. Efficiency vs. Output Current

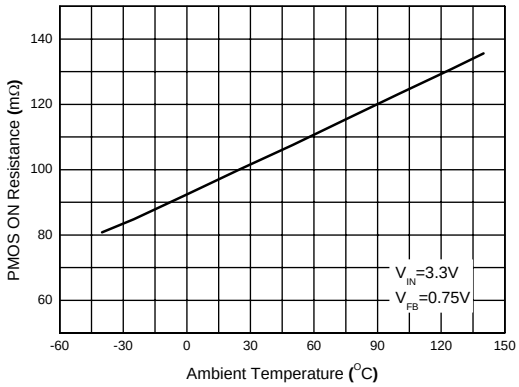


Figure 7. PMOS ON Reisistance vs. Ambient Temperature

Typical Performance Characteristics (Continued)

V_{IN}=V_{DD} =V_{PVDD}=3.3V, T_A=25℃, unless otherwise specified.

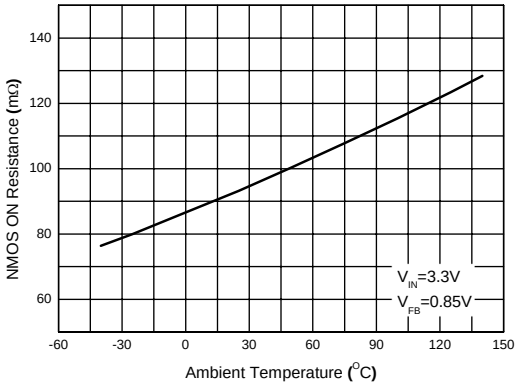


Figure 8. NMOS ON Reisistance vs. Ambient Temperature

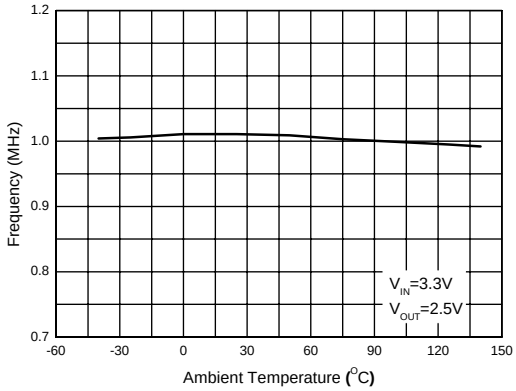


Figure 9. Frequency vs. Ambient Temperature

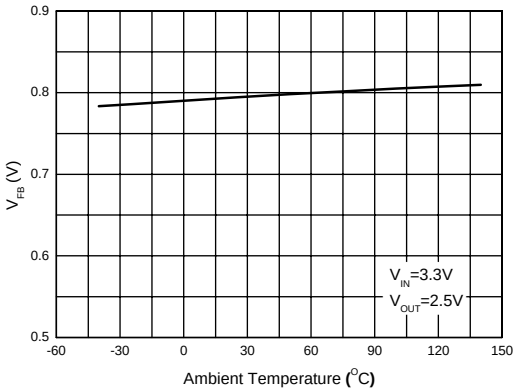


Figure 10. V_{FB} vs. Ambient Temperature

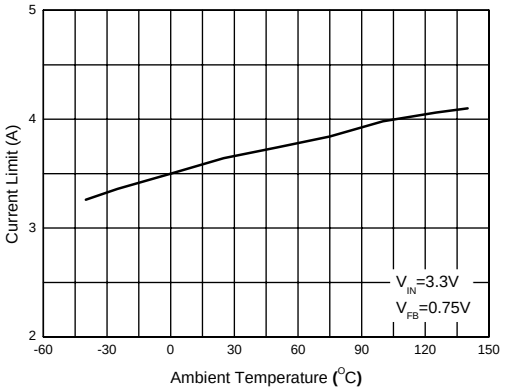


Figure 11. Current Limit vs. Ambient Temperature

Typical Performance Characteristics (Continued)

V_{IN}=V_{DD} =V_{PVDD}=3.3V, T_A=25℃, unless otherwise specified.

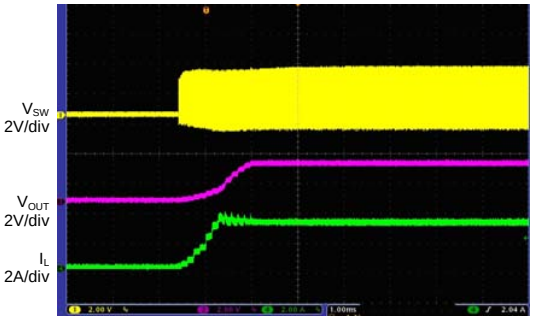


Figure 12. Start-up from VIN
(V_{IN}=3.3V V_{OUT}=2.5V, I_{OUT}=3A)

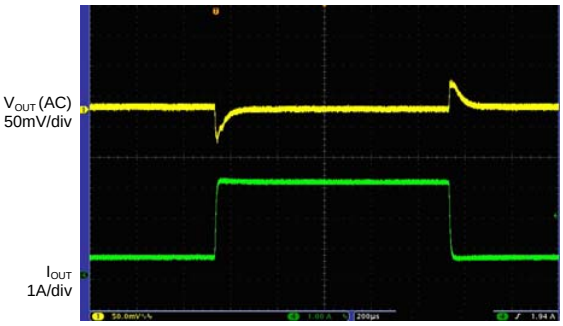


Figure 13. Load Transient Response
(V_{IN}=3.3V, V_{OUT}=2.5V, I_{OUT}=0.5 to 3A)

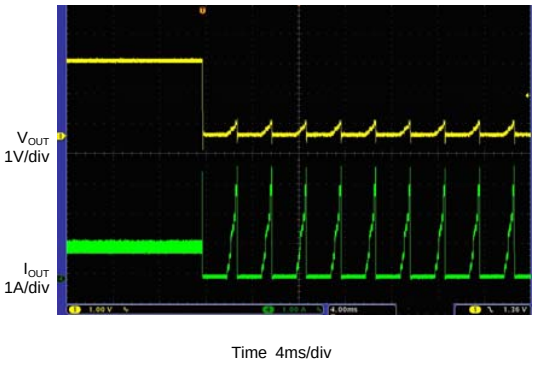


Figure 14. Short Circuit Protection
(V_{IN}=3.3V, V_{OUT}=2.5V)

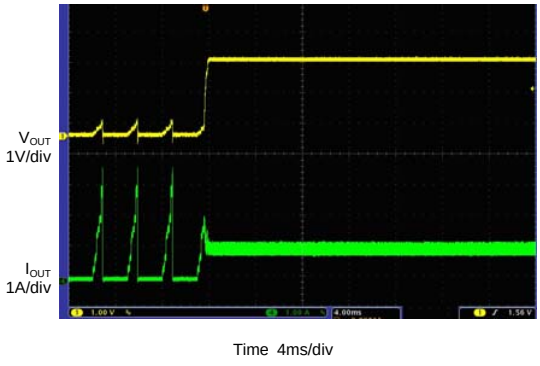


Figure 15. Short Circuit Recovery
(V_{IN}=3.3V, V_{OUT}=2.5V)

Typical Application

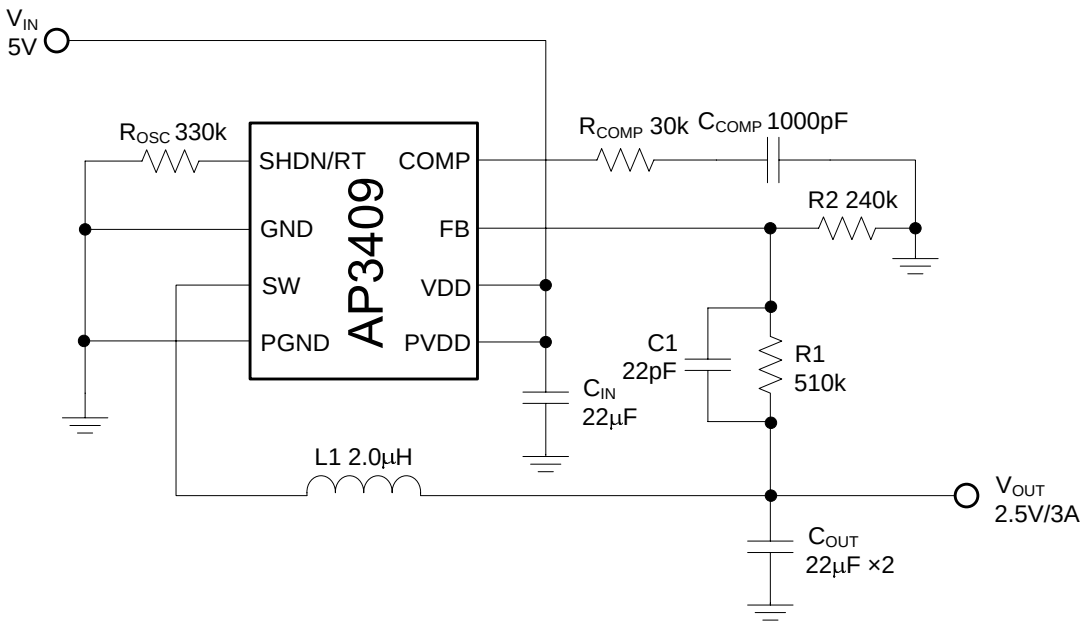
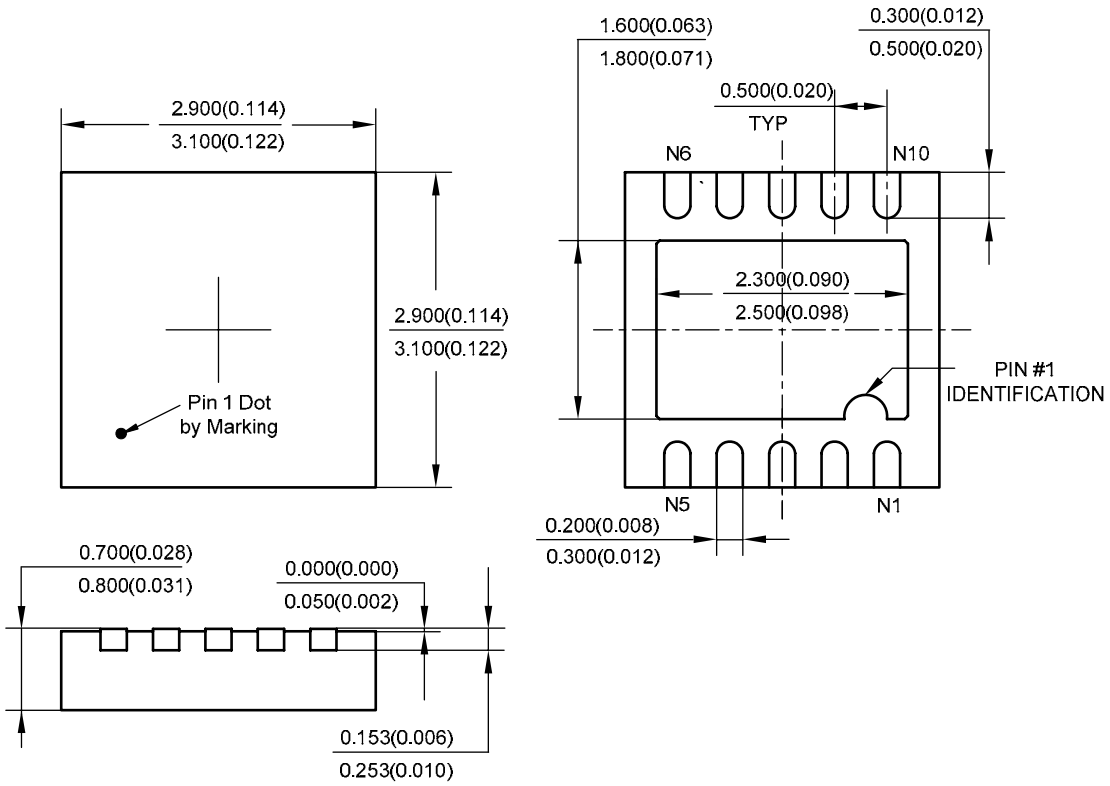


Figure 16. Typical Application of AP3409

Mechanical Dimensions

DFN-3×3-10 **Unit: mm(inch)**



BCD Semiconductor Manufacturing Limited

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